Abstract

In this thesis first the behavior of induction generators under unbalanced voltage conditions is studied. In this context, first the existing schemes for characterizing the unbalance in simple ways have been studied. The two schemes IEC, NEMA which are in use to quantify the unbalance, as an unbalance factor require the use of complex algebra. A new scheme to characterize voltage unbalance, without using any complex algebra has been proposed and its effectiveness is compared with the NEMA scheme. The performance of the induction generators under unbalanced voltage conditions is first studied using the symmetrical component approach and a detailed simulation. The machine currents for the same unbalanced conditions are estimated using the proposed scheme and its effectiveness is highlighted. Existing approximate schemes based on unbalance factor do not consider the phase differences between positive and negative sequence voltages while estimating currents. A method of including this feature is proposed here. A simple way to find the maximum line current among the three phases as a function of the positive and negative voltages has been proposed. Knowing the positive, negative sequence voltages and the angle between them, a scheme to compute the generator currents under unbalanced conditions is proposed. Finally a few affecting the machine heating due to unbalanced currents have been studied.

The nature of the induction generator fault currents is studied to understand their implication on the system performance. First the fault currents that have been recorded from experiments on relatively small induction motors(26kW and 122kW) are compared with those obtained through detailed dynamic simulation, in order to validate the usage of the detailed dynamic simulations to study the fault current behavior of the induction

machines in the absence of experimental or field records. In order to assess the impact of error in the measured machine parameters on the estimated fault current values, the sensitivity of the estimated values of fault currents to machine parameter variations is investigated. The fault currents in large grid connected induction generators (3MW to 500kW) have been estimated through detailed simulation. The effect of the instant of fault (w.r.t voltage cycle), input load levels and shunt capacitors on the fault current values is investigated. An eigen value analysis of the generator model has been carried out to understand the reasons for the observed behavior using the linearized machine model. Fitting functions have been adopted to quantify the fault currents, in order to facilitate comparison of fault currents.

A method of including induction generators into the system fault studies has been proposed. Methods of choosing proper sequence impedances for representing the induction generator have been developed and validated using simulated values of balanced and unbalanced fault currents. Simulations of self excited generators have been used for determining the unbalanced fault currents, so as to ensure that the induction generator fault currents correspond to only those contributed by the machine. The impact of the induction generators penetration on the short circuit levels is investigated considering a 14 bus test system by incorporating the proposed induction generator models in a system level fault study.